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An Analysis of FERC's Hub-and-Spoke Market-Power Screen

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1. Summary

The Federal Energy Regulatory Commission ("FERC" or "Commission") uses its hub-and-spoke market power screen to determine that applicants for market-based rates lack market power. That determination is often erroneous, and the hub-and-spoke screen is so deeply flawed as to provide no meaningful information on this question. The following will be demonstrated with regard to the hub-and-spoke screen as defined by FERC:

- Its geographical market definition accounts only for a factor that is no longer relevant and for none of the factors that matter in a competitive market.
- Its use of uncommitted-capacity shares registers more market power when the market itself is more competitive and less market power when it is less competitive. Thus it often reads in reverse the impact of the market on the applicant.
- It takes no account of the central market-power problem of electricity markets: the inelasticity of demand.
- It takes no account of the thousand-fold fluctuations in supply elasticity that concentrate and intensify market power during a few crucial hours.
- It takes no account of suppliers becoming pivotal to the market.
- It would allow a single supplier to pass its screen although it possessed enough market power to single-handedly double the average year-round price in a market as well behaved as PJM's.
- It would allow multiple suppliers to pass although they would be capable of destroying any current power market.

Such a "screen" misinforms, serves no useful purpose and should be immediately discontinued.

2. Introduction

Market-based rates are an important step for completing the transition from a regulated to a competitive market, but danger is inherent when the demand-side of the market is still not functioning normally. Demand-side response is one of two crucial factors in suppressing market power in normal markets, and it is missing in contemporary power markets. The other factor, supplier concentration, takes normal values in power markets. FERC’s hub-and-spoke test fails because it focuses on the normal factor, supply concentration, and entirely ignores the factor that causes problems for power markets.

That demand-response causes pricing problems is attested to by headlines recording electricity prices that have reached ten or even one hundred times their normal levels. No other market experiences such sharp spikes, and, as the press also explains, this is because consumers do not respond to these prices. Missing this point causes FERC’s hub-and-spoke market power screen to produce meaningless results.

A third key factor is that electricity cannot be stored and so its supply becomes completely inelastic at full output. This allows even small suppliers to become “pivotal.” They can push prices all the way to the price cap whether that is 10 or 100 times normal. Again, this well-known effect is entirely overlooked by the hub-and-spoke screen.

There can be no doubt that the hub-and-spoke screen misses the key aspects of market power. The unanswered questions have been, how much is at risk, and how far in error are the results of the hub-and-spoke screen likely to be. This report begins to answer these quantitative questions using examples from both the California wholesale energy markets and the Pennsylvania-New Jersey-Maryland (“PJM”) market.

The answers depend on the character of the market. For example, consider a large supplier, but one still small enough to pass the hub-and-spoke test. If it were granted market-based rates in an otherwise competitive market that matches PJM's market in size and in supply and demand characteristics, the damage to customers could be $10 billion per year. This is based on conservative calculations using PJM's 1999 price and load data. If the same supplier were introduced into a market which already contained other suppliers with market power (i.e. the California market scenario) the result would be worse, possibly by several hundred percent.

Besides being capable of such dramatic oversights, the hub-and-spoke method is simply illogical. FERC has previously concluded that the hub and spoke screen determines the geography by relying on a single factor that is no longer relevant and over-looking all factors that are relevant. As is demonstrated in Attachment A to this report, the uncommitted capacity share is as likely to increase as to decrease when market power increases. Relying on such a misguided indicator is only possible because it has never been tested (or at least tests have never been made public) on even the simplest textbook examples, let alone real-world situations. Finally, the hub-and-spoke screen simply ignores everything unique or central to the question of market power in electricity markets.

The hub-and-spoke screen is not an approximation to the truth that should be tolerated until something better is discovered. Capacity share is a factor, but it is far smaller than many other factors that are omitted. The hub-and-spoke screen is a dangerous fiction because it screens out almost no one from markets that are still only functioning on the supply side and are thus particularly vulnerable.

3. Basics of the Hub-and-Spoke Method

The FERC's general standard for granting of market-based rate authority is to allow power sales at market-based rates if the seller and its affiliates do not have, or have adequately mitigated, market power in generation and transmission and cannot erect other barriers to entry.[1] Regarding generation market power, the Commission requires an analysis of whether or not the applicant dominates the generation of power in the relevant market. This generation dominance analysis, in turn, relies upon the Commission's traditional hub and spoke methodology and a time-averaged market share threshold of concern of 20 percent.[3] This FERC policy for grant of market-based rate authority is reflected in its orders granting such authority. By way of recent example, in its "Order Conditionally Accepting Market-Based Tariff" for Huntington Beach Development, L.L.C, issued August 17, 2001 in Docket No. ER01-2390-000 ("August 17 Order")[4] the Commission concludes in full regarding generation market power:

> In support of its application, Huntington Beach submits a generation dominance analysis to demonstrate that **neither it, nor its affiliates, has market power** in generation within the relevant market. The Commission's hub-and-spoke analysis measures market share in both installed capacity and uncommitted capacity. Huntington Beach and its affiliates' share of the total installed capacity and uncommitted capacity in the relevant market area meets our generation market power standard for approval of market based rates. [August 17 Order, slip op. at 3, footnotes omitted, emphasis added].

This and other orders make clear that FERC's assessment of market power works as follows:

1. The applicant should perform the Commission's hub-and-spoke analysis which measures two market shares – committed and uncommitted capacity.
2. These shares are compared with FERC's market-power standard, which is generally 20%.

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[1] See e.g., *Pacific Gas & Electric Company*, 77 FERC ¶ 61,265, p. 62,083 (1996); *AES Southland, Inc.*, 94 FERC ¶ 61,248 (2001).

[2] It also allows market power provided it is adequately mitigated.

[3] See e.g., *Louisville Gas & Electric Co.*, 62 FERC ¶ 61,016 (1993), *Entergy Services, Inc.*, 58 FERC ¶ 61, 234 (1992) and *Public Services Company of Indiana, Inc.*, 51 FERC ¶ 61,367 (1990).

[4] 96 FERC ¶ 61,212 (2001), slip op. at 3

3. If the shares are less than the 20% threshold for concern, then the applicant is declared not to dominate the market.
4. From this FERC concludes “neither it, nor its affiliates, has market power in generation.”

This report disputes the conclusion in point 4 but not that of point 3. The concept of “dominating” a market has no commonly accepted definition in economics. Consequently, the conclusion in point 3 cannot be disputed. Point 4 concerns “market power” which is a central concept in economics and has a universally agreed upon meaning within the profession. Market power is the ability to raise the market price above the competitive level.[5] This clarity makes possible a careful assessment of the logic behind FERC’s claim that less than a 20% market share, calculated by the traditional hub-and-spoke method, implies an applicant has no market power.

Exercising market power is costly to consumers and necessitates FERC’s concern under the Federal Power Act. Also the lack of or adequate mitigation of market power has been named consistently and repeatedly by FERC to be the key to the granting of market-based rates. Therefore, if the absence of market power does not follow from FERC’s reasoning in points 1 through 3, FERC has, by its own standards, no justification for granting market based rates based upon its hub-and-spoke analysis, and the hub-and-spoke analysis serves no purpose.

This report demonstrates that steps one through three (1) fail to show a complete lack of market power as FERC claims, (2) fail to show the applicant has only minimal market power, and (3) are completely consistent with the applicant’s possession of nearly unlimited market power. Consequently, the use of the traditional hub-and-spoke market-power screen is without basis and meaningless.

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[5] Usually the increase is required to be profitable, and all exercises of market power considered in this report conform to that standard. Either definition, if used carefully serves the same purpose.

Three major steps must be taken when using FERC hub-and-spoke market power screen: market definition, calculation of shares, and comparison of shares with FERC's market power standard. Each will be discussed in turn. The final step of comparison, though trivial in execution, is the most crucial and the most erroneous.

4. The Hub-and-Spoke Geographical Market Definition

Applicants pass or fail the hub-and-spoke screen according to their market share, their capacity divided by the market's capacity. Defining the geographical regions of the relevant markets determines the markets' capacities, and thus directly determines the outcome of the hub-and-spoke screen. The regions are based on which suppliers various customers can reach directly, or through open access tariffs. Yet this approach ignores critical energy market factors. As Commissioner Massey has pointed out,

> … little or no account is taken of the important factors that determine the true scope of the electricity markets, such as physical limitations on market size including transmission constraints, prices, costs, transmission rates, and the variance of supply and demand over time. Virtually no seller ever fails this screen, and thus it is no screen at all. [*Order Dismissing Rehearing, Sierra Pacific Power Company et al.,* 96 FERC ¶ 61,050 (2001), Commission Massey dissenting at 1].

This echoes an earlier message of the FERC six years ago,

> A drawback of this method [hub and spoke] of defining geographic markets is that it does not account for the range of parameters that affect the scope of trade: relative generation prices, transmission prices, losses, and transmission constraints. [*Order No. 592, Policy Statement Establishing Factors the Commission Will Consider in Evaluating Whether a Proposed Merger is Consistent with the Public Interest*. 77 FERC ¶ 61,263 (1996), slip op. at 20].

FERC then concluded:

> Now that virtually all public utilities have open access transmission tariffs on file, it is no longer appropriate to recognize only the effect of certain entities' tariffs on the size of the market.. [Order 592, at 21].

In other words, under present market conditions, the only item the hub-and-spoke screen does take into account is now irrelevant (the extent of open access tariffs), and the four items that matter in an open market: (1) generation prices, (2) transmission prices, (3) losses, and (4) transmission constraints are all ignored. By 1996 FERC had recognized that the traditional hub-and-spoke method completely missed the mark regarding the determination of the relevant geographical market.

Both Commissioner Massey and the earlier FERC note that the hub-and-spoke screen does not account for transmission congestion. An example of this may illustrate the importance of his concern. Consider a generator located in San Francisco. It would be connected to PG&E and therefore the hub-and-spoke screen would compute its market share relative to this huge utility and a "first tier" of connecting utilities as well. But during roughly half of each day San Francisco is a "load pocket" and must buy its marginal MW from local suppliers, of which there are only two, because the transmission system into San Francisco has reached its limit for importing power. At these times local market power is extreme because the relevant market for city's customers is the city itself, a far smaller market than the "relevant" market of the hub-and-spoke test.

5. FERC's Re-Definitions of Market Share

The Commission has specified that market share be calculated from installed capacity and from uncommitted capacity. Although these measures are popular with regulators, neither corresponds to the definition of market share given in any economics or business text. Economics (and business) defines a supplier's share of the market to be its sales divided by the market's total volume of sales. A supplier is given no credit for building plants that are not used.

a. Share of Installed Capacity

Consider a supplier with 2 GW of installed capacity in a 10 GW market, so that its capacity share is 20% and it passes FERC's market power screen. Now let it build a new 500 MW plant, so that its share increases to 2.5/10.5 or 24%. Will this automatically increase its market power? No. A supplier cannot make money by building plants it never uses, and if it uses the plant it lowers the market price, particularly assuming a competitive market.[6]

Consider California's gas-fired units, with a combined capacity share of about 35%. Suppose a single supplier owned them. On weekend nights they still have their 35% capacity share and still fail FERC's market-power screen, but their economic market share is ordinarily 0%. They are out of the market due to low load conditions. How can they raise price if they are not in the market, and if they did, what good would it do them? The standard definition of market share captures this definition and correctly records that these suppliers ordinarily have no market power on weekend nights. As will be seen below, time variation of supply conditions is central to an understanding of market power in electricity markets. Capacity share cannot capture time variation, correctly defined market share can. This is one of many reasons the economic definition of market share has been accepted for over a century by those who understand markets.

But, FERC's installed capacity share is the most sensible part of the hub-and-spoke screen. During peak hours when, market power is most problematic, it will be numerically close to the correct definition of market share.

[6] It could substitute this plant for a more expensive one, but then it would not have increased its capacity. The only use of more capacity is to produce more output. It should, however be noted, that excess capacity can be used to

b. Share of Uncommitted Capacity

Uncommitted capacity is an important factor in evaluating market power, but FERC's use of it is half forwards and half backwards. The result is a thoroughly unreliable indicator. The uncommitted share is the ratio of the applicant's uncommitted capacity (AUC) to the market's uncommitted capacity (MUC). Thus when AUC goes up more market power is "detected," and when MUC goes up less market power is detected by the hub-and-spoke screen. According to the hub-and-spoke method, AUC and MUC work against each other. Commissioner Brownell's comments point to the flaw in this conclusion:

> The principal problem I have with hub-and-spoke analysis is that it focuses on the particular applicant's market share. I believe that experience indicates that a methodology that not only looks at individual market shares, but also examines **the market itself**, would be a far superior method. [August. 17 Order, Commissioner Brownell, concurring at 1 (emphasis added)].

When MUC increases, it is because the AUC of many different applicants has increased. Just as an increase in AUC indicates more market power for the applicant in question, so it is with all other applicants and thus for the market. An increase in MUC indicates a general increase in market power in the whole market. When MUC increases, AUC/MUC, the applicant's uncommitted capacity share, decreases. FERC's use of uncommitted capacity shares predicts a **decrease** in the market power of the applicant when the general level of market power in the market **increases**. It is as if FERC believed that suppliers were exercising market power *against each other* instead of against customers.

Consider the meaning of uncommitted capacity shares in the California context. The Investor-Owned Utilities ("IOUs") contribute nothing to the MUC because their capacity is

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deter entry by others. If this is the effect FERC is attempting to evaluate, it belongs under the heading "barriers to entry" and FERC should be looking at excess capacity not installed capacity.

committed to their load. Thus, they contribute nothing to the denominator and tend to make the applicant's share look large. The other sellers own and/or market the output of divested generation units and have uncommitted capacity, so they all contribute to MUC and thereby reduce the share of the applicant.

Incongruous results are produced. For example, California's wholesale energy markets can be viewed as containing the IOUs as well as five sellers with significant market share, Sellers 1 – 5. The uncommitted capacity share screen interprets the IOUs as giving Seller 1 more market power, while Sellers 2, 3, 4 and 5 make it much harder for Seller 1 to exercise market power by lowering its uncommitted capacity share from nearly 100% to near 20%. Yet, the reality in the California scenario is that the IOUs tend to inhibit the market power of Seller 1, while the presence of Sellers 2-5 tends to increase its market power and the damage the exercise of that market power can do within California's wholesale energy markets.

The notion of uncommitted capacity share may have been derived by analogy from the legitimate use of true market shares to construct the Herfindahl-Hirschman Index (HHI), and the correct notion that uncommitted capacity is a key component of market power. Unfortunately, casual analogies can be dangerous when conclusions are not checked.

c. Pivotal Suppliers

Attachment A analyzes the implications of market competitiveness for granting market-based rates by considering three types of markets (1) perfectly competitive, (2) monopolistic or un-competitive, and (3) monopsonistic or hyper-competitive. The less competitive the market, the more damage will be done by granting market-based rates to an applicant with market power. This is true both when load is low and when the applicant is a pivotal supplier. When load is low, the market will clear at the variable cost of some supplier. With low load, the effective elasticity of demand faced by the applicant (its residual demand curve) is higher if the market is competitive. So it exercises less market power in a competitive market.

As demand rises there comes a point where load plus operating reserves cannot be supplied without the output of the applicant. At this point and beyond the applicant is termed *pivotal*. In a market with normal generation adequacy, load exceeds supply for only 2.4 hours per year. But, the applicant would be pivotal for many more hours because markets require a total operating reserve of about 10%. Being short of operating reserves is what pushes the price to the cap. This key phenomenon is missed by the hub-and-spoke screen and analyzed in Attachment A.

When the market is not competitive to begin with (i.e. the California market scenario), there will be other suppliers withholding as the market gets tight. This will allow the applicant to become pivotal at a much lower load level, and because lower load levels occur much more frequently, the damage is multiplied. The hub-and-spoke screen ignores all time variation in markets and ignores the character of the market itself, so it cannot begin to detect this critical phenomenon. Attachment A analyzes how the market's character affects suppliers. The following section assesses the magnitude of the damage that could be done by a single supplier granted market-based rates under the hub-and-spoke screen.

6. The 20%-Share Market Power Standard

To avoid redundancy, this section will assume that the hub-and-spoke method has had its geographic definition replaced with one that works, and that the topsy-turvy uncommitted capacity share has been abandoned. Equivalently, one could simply imagine applying the current method to a unified market with no transmission constraints and in which all capacity is uncommitted. This allows scrutiny of the 20% standard without risk of attributing problems to it that belong to other parts of the method.

Any supplier with less than a 20% share of the relevant markets is generally deemed not to possess market power. While having no basis in economic theory, 20% reflects a tradition in applied industrial organization. Traditionally markets with either 5 or 6 equal players sometimes have been considered to be “workably competitive.” Five equal players would each have a 20% market share. While there is a grain of truth to this rule of thumb, it was never been intended to be a test for the absence of market power, and it was intended to apply only to markets with *normal demand responsiveness*. Power markets represent the worst-case scenario with regard to demand elasticity, making the tradition particularly inappropriate for these markets.

a. The 20% Standard in a Normal Market

The standard economic model of the exercise of market power, known as the Cournot model, represents non-collusive, unilateral behavior. It provides the most objective measure of what FERC’s standard would indicate in a normal market.[7] Consider a market with five identical suppliers each of which has a capacity share of 20%. Such a market has an HHI of exactly 2000. Suppose that the responsiveness of demand to price is described by an elasticity of one. That is, a 10% price increase causes a 10% decrease in demand.

The formula for market power exercised according to the Cournot model is

$$(Pm - Pc) / Pm = HHI / \text{elasticity},$$

[7] In a recent study conducted by the University of California’s Energy Institute, Steven Puller concluded that the five large non-utility suppliers had behaved in accordance with the Cournot model during 1998 and 1999 and somewhat less competitively during 2000. See Puller, Steven L. “Pricing and Firm Conduct in California’s Deregulated Electricity Market.” July 2001. http://www.ucei.berkeley.edu/ucei/PDF/pwp080.pdf

Where Pc is the competitive price and Pm is the market-power price. (When used in a formula HHI is first divided by 10,000 to make it a fraction between zero and one.) In the present example,

$$(Pm - Pc) / Pm = 0.2/1$$

This implies that Pm, the market-power price, will be 1.25 times the competitive price. If, in a normal market, all suppliers just met FERC's 20% standard, the Cournot model of market power would predict a 25% markup over the competitive price due to the exercise of market power[8]. This may be compared with the Department of Justice's definition of a "Hypothetical Monopolist" which requires the ability to raise price by 5%.[9]

Again, incongruous results occur. In a normal market, FERC's market power standard would amount to blessing a 25% markup over competitive prices. Does this mean FERC considers such an increase to be within its "zone of reasonableness" which is defined to include all rates that are not exorbitant?

> … the Commission must serve a *legitimate* statutory objective and produce a rate that is within a "zone of reasonableness." This zone is "**bounded** at one end by the investor interest against confiscation and at the other **by the consumer interest against exorbitant rates**." *Order on Rate Filing, Entergy Services, Inc.*, 58 FERC ¶ 61,234 (1992) (emphasis added).

Even assuming the FERC somehow considers such an increase to be within its "zone of reasonableness," the next section demonstrates that actual power markets, which lack a normal demand-side response, allow suppliers who pass the hub-and-spoke screen to profit from markups that are exorbitant by any standard.

[8] This comparison overstates the difference because the Lerner index measures both the increase in price and the reduction of a supplier's marginal cost due to the exercise of market power. In the flat region of the supplier curve the overstatement is small and in the steep portion it is significant.

[9] See U.S. Department of Justice and Federal Trade Commission 1992 Horizontal Merger Guidelines.

b. Lack of Demand Response: Near-Zero elasticity

There are two primary inhibitors of market power: (1) competition between suppliers, and (2) consumer response to price increases. FERC's standard takes some account of the former but ignores the latter entirely. The Cournot model, though imperfect, gives a qualitatively correct indication of the role of elasticity in suppressing market power. As elasticity (responsiveness) increases, market power is suppressed and as elasticity decreases, market power increases dramatically.

Electricity markets are notorious for their lack of demand response. Intra-day wholesale price fluctuations are most dramatic, sometime rising from about $50 to $500 or $1000 in only a few hours. To suppress such increases, customers would need to see the price and respond quickly, but, within this time frame, demand is almost completely unresponsive. Elasticity is nearly zero. Most customers have no reason to pay attention to such price changes, as they would receive no credit for responding during high-priced hours. Their meters record only monthly totals and not whether they reduced consumption during certain hours. Even the large industrial customers with appropriate meters are rarely billed on this basis. Since customers cannot save the cost of high prices by reducing their demand, they simply do not respond to wholesale price changes.

If a supplier exercises market power and quadruples the price in a normal market, customers cut back dramatically on their demand, perhaps buying only one quarter their usual amount. If a power supply exercises the same market power, quadrupling price, it need fear no such reaction from customers. It can depend on customers purchasing just as much as if the price had not changed. FERC's hub-and-spoke analysis completely ignores this crucial characteristic of power markets, which is its most important source of the market-power problems. In short, the hub-and-spoke screen misses the very essence of market power problems in electricity markets.

Hourly demand responsiveness is near zero in contemporary electricity markets, but, to be cautious, suppose it were 0.25 (instead of 1 as was assumed for a normal market). Customers would reduce their usage by a phenomenal 25% when wholesale prices doubled. Certainly, no U.S. market has come close to this level of price response. Recalculating the above standard model with this elasticity gives:

$$(Pm - Pc) / Pm = HHI / elasticity = 0.2 / 0.25 = 0.8$$

$$(Pm - Pc) = 0.8 Pm$$

$$0.2 Pm = Pc$$

$$Pm = 5 * Pc$$

This change in elasticity, from 1.00 to 0.25, increases the market-power markup from 25% to 500%. This is but a small taste of the demand-elasticity effect which the hub-and-spoke screen entirely overlooks.

The press has not overlooked this effect; it has made the headlines frequently during the past year. It governs price increases caused by real scarcity and by the artificial scarcity of market power. Only electricity markets exhibit 100-fold price increase in the space of a few hours because only electricity markets have near-zero elasticity in the relevant time frame. This is the most essential fact governing electricity markets. It has been recognized repeatedly by FERC and the press in almost every relevant context except the granting of market-based rates.

Again, consider the five suppliers allowed by hub-and-spoke. As reducing demand elasticity towards 0.20 increases the realism of the model, still far above its actual value, the market price rises without limit. The meaning of this mathematical result is that suppliers in such a market could and would raise price until it went so high that institutions (most likely a price cap) stopped it or consumers developed some responsiveness. California consumers have become more responsive, but still not quick enough to stop the kind of market power the hub-and-spoke screen would allow. Five equal suppliers, all without long-term obligations, would do many times the damage witnessed in California if they were not stopped by other means. These prices would not meet FERC's test for not "just and reasonable;" they would be truly exorbitant.

c. Why Market Power is Less than FERC Allows

Actual market power in electricity markets is less than is allowed under the hub-and-spoke screen because many suppliers want to hold prices down. Although the hub-and-spoke screen would allow all suppliers to be aggressive and effective exercisers of market power, not all suppliers currently fall into that category. Most generation is still owned by old-style utilities with obligations to serve load and often with too little generation to meet those obligations. These "suppliers" are net purchasers of power and so prefer a low price not a high price. Even suppliers without native load often have long-term contracts that inhibit their market power.

The above example demonstrates the chaos that would be caused if no suppliers had long-term obligations and only wanted higher prices. Having suppliers with the opposite motive not only reduces the number of suppliers pushing the price up, but also makes the exercise of market power more difficult for those who want high prices.

This means there are two polar extremes to consider: (1) the market may be entirely composed of suppliers who profit form higher prices on every unit they sell, and (2) only one supplier, the "applicant," might be inclined to exercise market power and all others might be perfect competitors. The Cournot model considers the first case, which is important because it warns of the dangers of FERC's hub-and-spoke method in a market with nearly all generation divested from the old utilities. This is the type of market envisioned as the end result of re-structuring.

The second polar case is a useful test of whether the hub-and-spoke screen is sufficiently cautious under the most favorable circumstances, when *the market itself* is not part of the problem. Even in this *benign case*, having near-zero elasticity still causes the hub-and-spoke screen to fail.

d. California Lies in Between the Two Extremes

Supplier	Capacity (MW)
Williams / AES	3,921
Reliant	3,698
Duke	3,343
Southern	3,130
Dynegy	2,871
Total	**16,963 MW**

At one extreme, the market is composed of suppliers, all of whom wish to raise price and at the other extreme the market is entirely competitive except for the applicant. In the more benign case, the market itself is competitive, but one supplier, "the applicant" for market-based rates has market power. California lies in between the two extremes. Again, consider California as containing five suppliers with a significant market share and a desire to raise prices. Steven Puller at the University of California's Energy Institute has made a thorough contemporary study of the exercise of market power by these suppliers.[10] He lists their capacities as shown in the table above. He found that in 1998 and 1999 their behavior was consistent with the Cournot model, and that in 2000, they were even less competitive. This shows that California's market is not at the benign end of the spectrum and each supplier will find that the rest of the market looks less than competitive and so more conducive to the exercise of market power.

[10] See n.8.

e. The Variation of Supply and Demand Over Time

To analyze the more benign case as well as most real-world cases, such as Californiait is necessary to address the variance of supply and demand over time. The effect of these variations cannot be underestimated, yet they are ignored by the hub-and-spoke method. In the present example, it will be seen that the applicant would exercise no market power for 8030 hours per year, but would raise the price to over $900/MW hour for 230 hours per year, and raise to over $400/MWh in 500 hours. This picture gives the correct flavor of a power market. The vast majority of market power is exercised during extreme market peaks during just a few percent of the hours, when some supplier is pivotal.

The Variation in Supply Elasticity

Again elasticity lies behind the effect, but this time supply elasticity, not demand elasticity, makes the difference. (Supply elasticity is the percent change in output divided by the % change in price that would cause it.) When demand is low, supply elasticity is enormous (e.g. 500% or more), while in high demand conditions supply elasticity drops to near zero. Sometimes an increase in load of only 1 GW (2.5%) can cause PJM's price to increase 500%. This indicates a supply elasticity of one half percent. (%dQ / %dP = 2.5/500 = 0.005.) This thousand-fold change in supply elasticity goes unrecognized by the hub-and-spoke procedure. When supply elasticity is high then any withdrawal of supply by one player need only cause the slightest increase in price to call forth its replacement by another player. Thus, the costly withdrawal of capacity from the market (either physically or economically by bidding high) is rewarded with an exceptionally meager price increase, and market power is inhibited.

Low supply elasticity drives the market power that invalidates the hub-and-spoke screen in the benign case (and amplifies the problems already uncovered at the other extreme). Demand elasticity is always near zero, and when supply elasticity falls to these levels there is nothing left to protect the consumer. Even a very small supplier can drive prices to exorbitant levels. When 1 more GW of load will raise the price from $100 to $500, then a supplier can cause the same effect by withdrawing 1 GW of supply. If the supplier has a 2 GW share of the market and a marginal cost of $20, then it is making a profit of 2000 MW x ($100 – $20) before withdrawing supply, and will make 1000 MW x ($500 – $20) after exercising market power. This is a handsome increase in profit. With PJM's market size (installed capacity), including imports, of 60 GW, the supplier has a capacity share of only 2/60 or 3.3%. With this tiny share, it can profitably cause a 400% price increase at the right time. The $400 price increase would affect all spot trades in the PJM market, which would be on the order of 3 GW, so the one-hour cost would be $1,200,000.

This is all the more relevant to California. Earlier this year, forced outages and low hydroelectric production caused low supply elasticities in California and Western electricity markets. A supplier with as little as one percent of California's peak load, a few hundred MW, could have had a similar effect on price in California markets.

f. A Single Rogue Supplier in a Perfect PJM Market

The more interesting question is how these exercises of market power would add up over the course of year in a real market. Consider the possibility that a single supplier with a 20% capacity share appeared in PJM's market in 1999 and, passing the hub-and-spoke screen, was granted market-based rates. Suppose the market were perfectly competitive except for this one supplier, and that the supplier, as California suppliers once did, traded entirely in the spot market. What would have been the effect on the market? By a conservative estimate:

- Average price for the year would have increased from $28 to $73/MWh

- The supplier would have earned $1.2 billion in excess profits.
- The cost of power traded in the spot market would have risen by $4.3 billion.

Forward markets would have taken the increase into account and the total cost to end-use customers would probably have been over $10 billion. The outcome would be expected to be even more severe in markets, such as California, experiencing less competitive conditions that PJM. The hub-and-spoke screen does nothing to stop such egregious outcomes; in fact it stops nothing at all. Other factors have to operate to stop such dramatic results such as suppliers not being sufficiently concentrated, long-term obligations, or prices constrained by regulatory factors in the market other than FERC's hub-and-spoke "screen."

The calculations were made as follows. PJM's installed capacity plus imports was about 60,000 MW in 1999. Twenty percent of this is 12,000 MW. About 5% of the capacity would be forced out of service due to legitimate malfunctions during the crucial times for exercising market power, so the available capacity for the rogue supplier would be over 11,000 MW, but was model as exactly 11,000.

The 1999 relationship between load and price is summarized in the following table:

Range of load in MW	Average Price in $/MWh	Assumed load threshold for to cause this price
51,000 – 51,714	**$920**	**52,000**
49,000 – 51,000	**$484**	**51,000**
46,000 – 49,000	**$442**	**49,000**

The supplier can effectively push load up by withdrawing its supply of generation. It does this by bidding as high as possible, which is assumed to be $920/MWh, the actual price when load was over 50,900 MW, but not the highest price of the year. To be conservative, it was assumed that the supplier would have needed to, in effect, push load over 52,000 to achieve a price of $920. Similarly, price averaged $484 when load was between 49 and 51 GW, but it was assumed that the rogue supplier would have needed to, in effect, push load above 51 GW, to achieve this price. The threshold for the $442 price was placed similarly at the top of the range. All possibilities of exercising market power at lower levels of price and load were ruled out for simplicity. This may have caused a significant downward bias in the estimate because it excludes 90% of the hours.

For each hour, four strategies were contemplated: (1) no withholding, (2) withholding enough to raise the price to $442, (3) withholding enough to reach $484, and (4) withholding enough to reach $920. In many peak hours, withholding makes no sense because the price was already high. In these cases no market power would have been exercised. This assumes that none of the high prices in PJM in 1999 were due to market power (the benign case assumption). If they were, then a true competitive case would have allowed more scope for the exercise of market power by the rogue supplier. In very low-load hours, the supplier could not withhold enough to push the price up and still have sufficient supply left in the market to make it profitable. (Because of the assumption that it must push price to $442, or not at all.)

For conservatism it was assumed that the only spot market trades were the sales of the rogue supplier or the sales of those who replaced the power withheld by that supplier. The extra cost of wholesale power is then (Pm – Pa)*11,000, where Pm is the price caused by the exercise of market power and Pa is the price that actually occurred in that hour in PJM, in 1999.

For example, in one hour load was 48,665 MW and the price was $620/MWh, which would have resulted in a profit for the applicant of $6,271,000/h. This is based on an assumed marginal cost of $50 and capacity of 11,000 MW. Withholding 335 MW of capacity would have had the same affect as increasing load to 49,000 MW, but that would have pushed price only up to $442, which is to say not at all. To profit, the rogue supplier would have had to withhold (according to the conservative model used) 3,335 MW and effectively push load to 52,000 MW. Then price would have increased to $920/MWh. The supplier's profit would have been (920 – 50) x (11,000 – 3,335) or $6,760,000. This is only $397,000/h more profitable than not withholding, but it would have cost customers (920 – 620) x 11,000 or $3,330,000/h more. This type of calculation was performed for all hours of the year and the results were summed.[11]

Most trading takes place in forward markets, not in the spot market, but these markets are strongly influenced by the spot market. Economic theory predicts the forward price will equal the expected spot price. Consequently the spot market price increases would soon affect the forward markets and within months the short-term forwards (one to three months) would have reflected almost the entire spot price increase. Consequently the total cost impact would have been multiplied several fold.

7. Summary

On January 25th, 1990, the Electricity Consumers Resource Council (ELCON), filed comments which FERC summarized in part as follows,

> ELCON states that the Commission should refrain from using a 20 percent market share (i.e., that a dominant firm is one that has a 20 percent or greater share of the market) as a reliable measure of market power. ELCON opposes the use of such bright line rules with precedential implications in the context of an individual rate filing. *Public Service Company of Indiana, Inc.*, 51 FERC ¶ 61,367 (1990), slip op. at 22.

[11] It must be noted that a supplier with less than a 20 % capacity-share can also affect a significant influence on prices. For example, using the same calculation methodology as described above, a supplier with a 15% capacity-share would have 8,250 MW to withhold (instead of 11,000) resulting in the cost of power traded in the spot market rising by approximately $2.1 billion.

Immediately after this summary, FERC assures ELCON that it need not be concerned about FERC setting such a precedent because FERC understands that a 20-percent-share market-power screen by itself would prove nothing. FERC wrote as follows,

> However, we do not believe that any one type of evidence is sufficient for this analysis, and we will not rely on any mechanical market share analysis to determine whether a firm has market power. Thus, PSI's market share is not, in itself, sufficient to guarantee that PSI lacks market power. **Market concentration figures alone do not demonstrate the existence, or lack, of market power**, … [*Id*. At 23 (emphasis added)].

Now, eleven years later, FERC refers to their "traditional" market power screen. But the current test is a corruption of FERC's original procedure. Eleven years ago FERC understood this test was insufficient. Six years ago they diagnosed it as "no longer appropriate." As of this year, certain Commissioners again emphasize that this test is outdated and unreliable. But still FERC insists, "… at this point, we are not prepared to abandon the hub-and-spoke analysis." It should take little preparation to abandon a screen that does nothing. FERC could not do worse.

Attachment A
Effects of the Market on the Exercise of Market Power
(And the Irrelevance of Uncommitted Capacity Share)

This Attachment provides a basic analysis of how the market matters to the evaluation of applicants for market-based rates. It considers three types of markets (1) perfectly competitive, (2) monopolistic, also called un-competitive, and (3) monopsonistic, also called hyper-competitive. Each of these consists of a 30 GW "fringe" of competitive suppliers, plus a 10 GW "swing" supplier that will take on three different roles, plus a 10 GW supplier that is an applicant for market based rates. The swing supplier determines the character of the market, which depends on whether it is competitive, monopolistic, or monopsonistic.

The competitive fringe is assumed to be made up of generators who act competitively either because their capacity is committed in very-long term contracts (perhaps vesting contracts with the utility from which they were divested) or because they are too small to exercise market power even though their capacity is uncommitted.

The swing supplier may be either a utility with load obligations, or an independent generator with uncommitted capacity. When the swing supplier is a utility, it is committed to supply the entire load in the market at a regulated price.[12] Because it must buy most of its power, it seeks a low market price. It can pursue one of two strategies: act as a perfect competitor, or act as a monopsonist. While profit maximization dictates the later strategy, there is some evidence that utilities are not yet this clever, so both strategies will be considered.

[12] This assumption is strong, but makes only a small difference in the outcome. It exaggerates the power of the utility to lower price when it is assumed to act as a monopsonist.

The applicant for market-based rates will be assumed to act competitively as the generators in PJM did during its first year of operation starting on April 1, 1998. Once granted market-based rates, it will be assumed to maximize profit, by exercising market power.

Market Type	**Competitive Fringe's Un-Committed Capacity**	**Swing Supplier Type (Un-Committed capacity)**	**Applicant's Un-Committed Share**	**After MBRs w/ Load = 25 GW**		**% Hours Applicant Forces Price > $100**
				% P increase	**With-holding**	
Un-Competitive	30 GW	Monopolistic (10 GW)	**20%**	4.6%	1.39 GW	**40%**
Competitive	10 GW	Competitive (0 GW)	**50%**	2.8%	1.04 GW	**8%**
Hyper-Competitive	0 GW	Monopsonistic (0 GW)	**100%**	0.0%	1.04 GW	**8%**

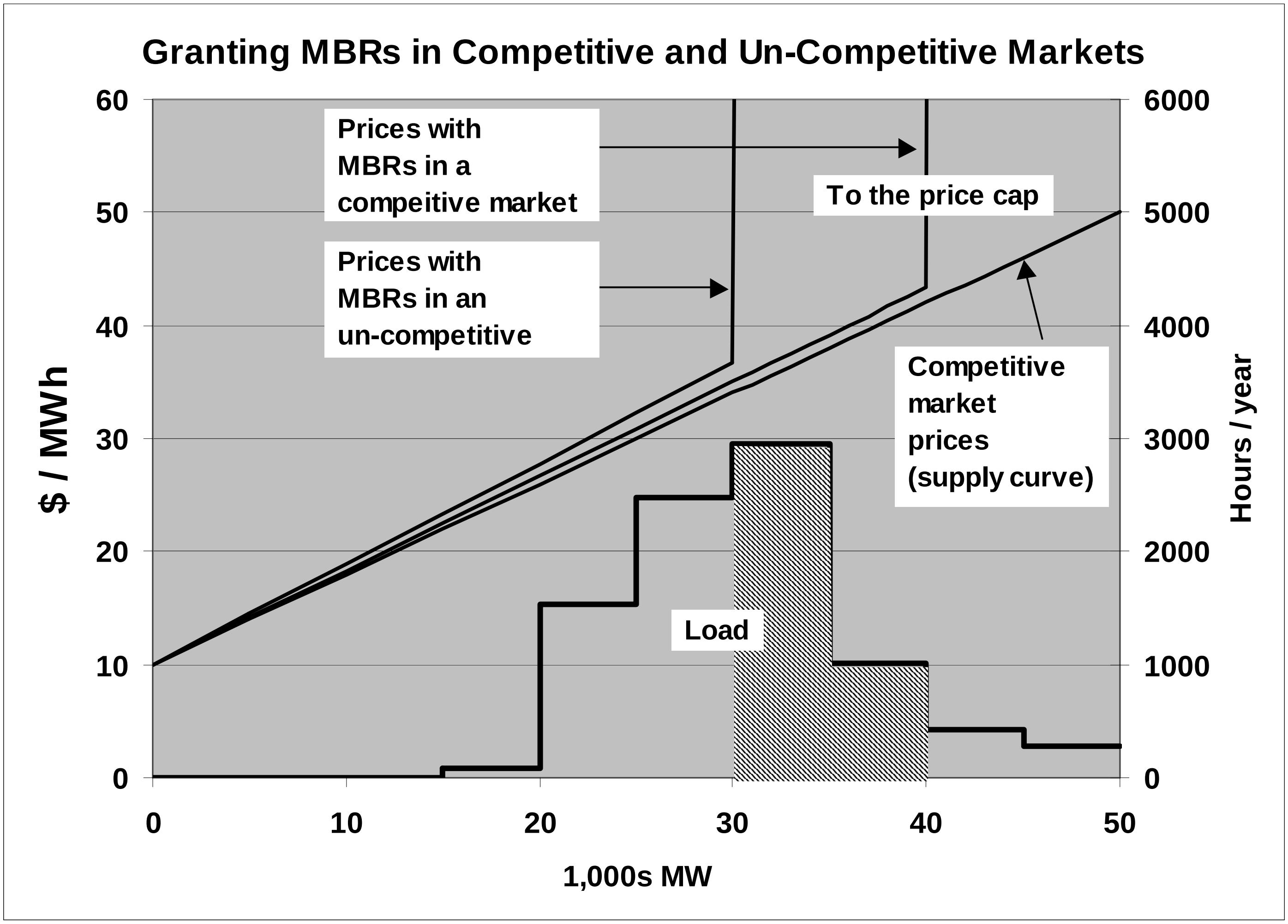
The above table describes the three scenarios and characterized the outcome at 25 GW, a relatively low level of load, and gives one statistic for the peak hours. The graphs on the following pages show more detail. In the *un-competitive case*, the competitive fringe is still competitive but the market is somewhat uncompetitive because the swing supplier is large (owns 20% of the capacity) and its capacity is uncommitted. Because all capacity is uncommitted in this scenario, the applicant's uncommitted capacity share is only 20%. When the applicant is given market-based rates, it withholds 1.39 GW of its capacity and thereby raises the market price by 4.6%, when load is 25 GW.[13] More to the point, it becomes a pivotal supplier able to force prices to the price cap in many hours. By taking advantage of this role it increases price dramatically in 40% of the hours in addition to the 8% of the hours during which the swing supplier was already able to do this.

[13] The 4.8% increase is lower than the 25% predicted in Section 6.1 because the 25% referred to the Lerner index, which measures the decrease in the supplier's marginal cost as well as the increase in the market price.

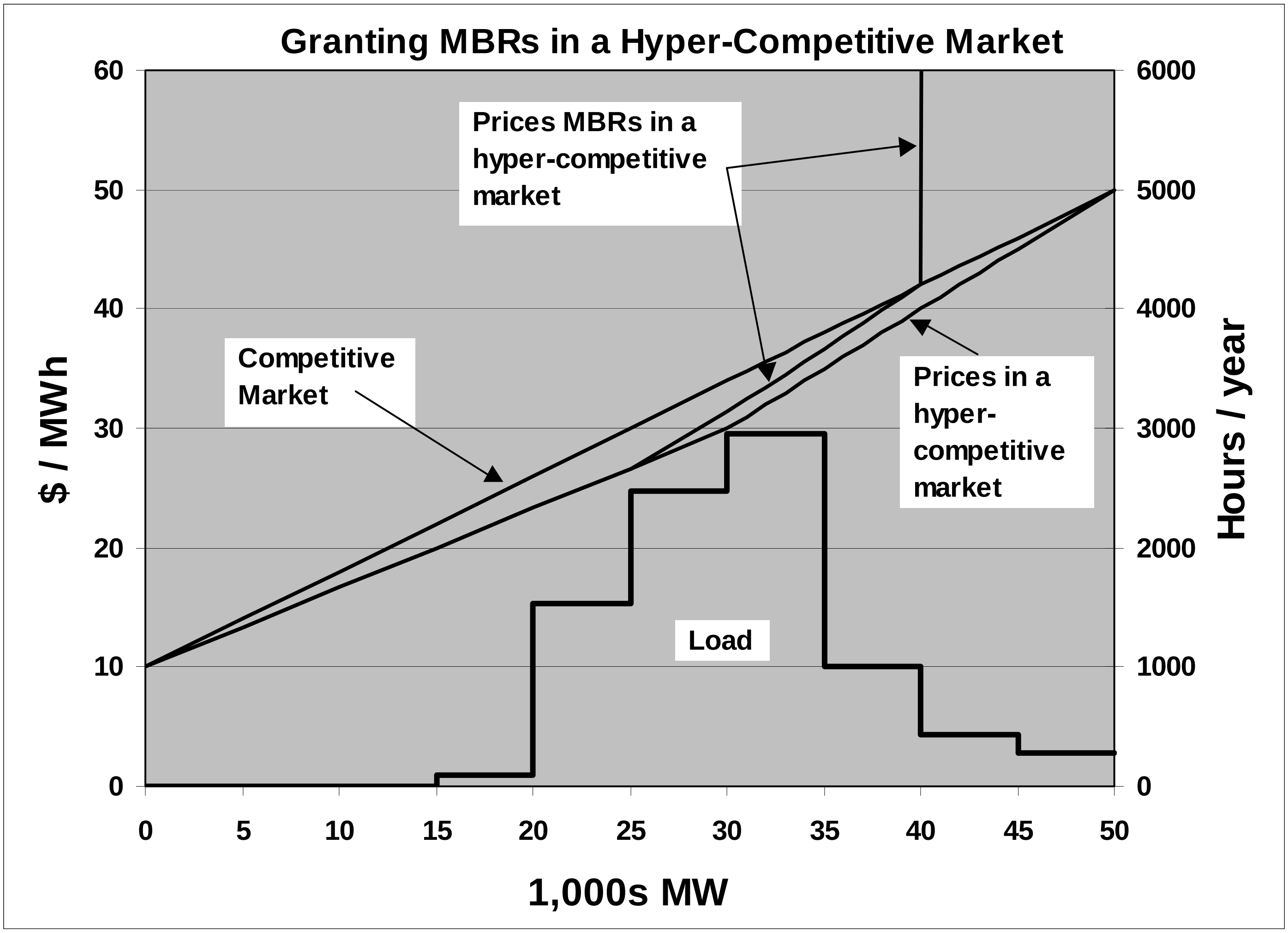
In the *competitive case*, the swing supplier is a utility that would like a low price, but which nonetheless acts competitively. Its generation is fully committed as is 10 GW of generation in the competitive fringe. In this case the applicant's damage is more limited because the 10 GW range over which it acts as the pivotal supplier coincides with the extreme peak hours of the market which are few in number.

In the *hyper-competitive case* the swing supplier is again a utility with obligations to serve all load. It wants a low market price and is assumed to maximize its profits by exercising market power to *reduce* the market price. It is successful in this in all hours before the applicant is granted market-based rates, but fails after they are granted because it cannot restrain a pivotal supplier. Again because the applicant is entering a market without fellow oligopolists, it is limited to playing this role during the peak hours.

The example shows that the severity of the exercise of market power may *increase* as the uncommitted capacity share is *reduced*. It also shows the crucial aspects of market power are those caused by the super-low elasticities found in contemporary power markets.



The above figure, "Granting MBRs in Competitive and Un-Competitive Markets," shows the market price as a function of load. As can be seen, granting market-based rates in a market with one oligopolist does more damage at both high and low load levels than does granting market-based rates in a competitive market. At low load levels this is a minor effect, prices are merely pushed up twice as much and the percentages are small. At high load levels the effect is dramatic. A market already suffering from market power has a lower load-threshold for pushing prices to the cap, so granting market-based rates allows an applicant with market power to exercise its power as the pivotal supply more frequently. The same is true of a market suffering from a capacity shortage. Both situations apply to the California market. The shaded area of the load distribution curve shows this effect. This curve represents 1999 PJM loads scaled slightly to fit the present example.



The above figure, "Granting MBRs in a Hyper-Competitive Market," illustrates the effect of granting market-based rates in a market that is dominated by utilities with obligations to serve native load. Assuming these have divested some generation they will be net buyers and will want to hold the market price down so that they can purchase power cheaply. If the other suppliers are competitive, then the utilities will successfully lower the market price, assuming they are maximizing profit. This is done by the same technique, but in reverse, and is used to raise the market price. Producing more than the competitive level lowers price, just as withholding raises price.

Granting market-based rates to a large supplier without long-term obligations creates a countervailing force. At low output levels, the oligopsonist utility increases output even more and counteracts the withholding of the oligopolist applicant.[14] At higher load levels the applicant raises price *towards* the competitive price level and so does not exercise any market power in this region. It exercises market power only when it becomes a pivotal supplier, but once again this is what matters. This is the case in which the applicant has a 100% uncommitted capacity share, and in this case, contrary to the hub-and-spoke standard, it does the least damage.

These examples demonstrate two effects. In low to moderate load conditions, the more competitive the market, the smaller the price increase caused by granting market based rates to a supplier with market power. This effect is quite strong, but the amount of market power exercised under these circumstances is relatively small. The second effect is stronger and applies when market power is dramatic. A less competitive market causes an applicant to be pivotal during more hours. The increase is essentially exponential up the point where so many hours are affected that average prices have more than doubled.

Technical Description of Modeling

The competitive market supply curve, as shown in the two figures, is linear from \$10/MWh at zero output up to \$50/MWh at 50,000 MW. The swing supplier and the rouge

[14] This surprising point is caused by the fact that the residual demand curve of the utility becomes less elastic when the applicant switches from competitive to oligopolistic as a result of gaining market-based rates. With a less elastic residual demand curve, it exercises more monopsony power.

supplier each own generation that is the same as the market's except for being scaled down by a factor of five.

The swing supplier when not acting competitively is assumed to act as a Cournot competitor, that is, when it maximizes profit, it takes the output of the rogue supplier as given but takes the output of the competitive fringe to be price elastic. The rogue supplier, after the grant of market-based rates, is assumed to act similarly.

When both act as oligopolists, there are many "cooperative" Nash equilibria in which the two withhold just enough to force prices to the cap whenever this is profitable. There is also a Nash equilibrium that ignores this profitable possibility. The above example assumes these two possibilities are equally likely and averages the two price outcomes. This overstates the expected price in some cases and understates it in others, but even if the cooperative Nash equilibria were never achieved, the qualitative results would stand, as the rogue supplier can still rely on the normal Cournot withholding of the swing supplier to make him pivotal at lower (more frequent) load levels.